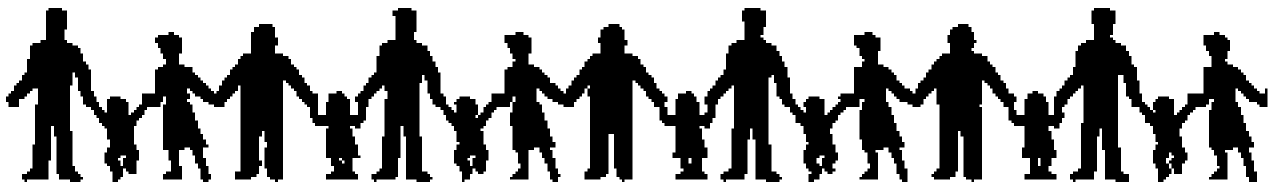

HEMI-SYNC AND THE FACILITATION OF SENSORY INTEGRATION

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SENSORY INTEGRATION

Learning is presumed to be a function of the brain, and disorders of learning reflect a deviation in neural function. Sensory input plays a critical role in brain function. Sensations from hearing, vision, taste, smell, touch, pressure, and movement provide the input to the brain which is organized for movement, cognition and learning. The richness of the sensory environment and the interactive experience of the individual with the environment contribute to the growth of intelligence.

Sensory integration is a term used to describe the way in which the brain sorts out and organizes for our use the many sensations which we receive. It allows us to "put together" parts to create a whole; it attaches meaning to sensations through comparing them with past experiences; it enables high levels of motor coordination; it is the basis of perception.

Individuals experience varying degrees of sensory integration. None of us organizes sensations perfectly. There is a continuum of skill in sensory processing and integration. A high level of sensory integration may enable an individual to be a skilled gymnast or artist. Most of us have average abilities in this area. The normally functioning person with low normal sensory integration may be physically clumsy or dislike being in a noisy environment.

SENSORY INTEGRATIVE DYSFUNCTION

About 5-10% of our children have enough problems with sensory integration to cause them to be slow learners, have specific learning disabilities, or have behavioral problems. Children with the poorest sensory integrative abilities usually have great difficulty functioning in our complex sensory world and may fall within the diagnostic categories of severe mental retardation and autism.

In sensory integrative dysfunction the brain does not process or organize the flow of sensory impulses in a way that gives the individual precise information about himself and the world. Learning is very difficult and the child often feels uncomfortable about himself and has difficulty coping with stress and demands. This often results in additional emotional or behavioral difficulties.

There are many different characteristics of these children. Some of the more common differences in their early development include:

- Delays in learning to sit up, stand, walk, or run, tie shoes, or ride a bike because the brain doesn't put together information needed to develop coordination. The child often has low muscle tone because of poor organizations of sensations from the vestibular and proprioceptive systems.

- Delays in early language development because the child doesn't interpret information from hearing correctly or has difficulty figuring out how to make the mouth move to imitate the sounds that are heard.

- Difficulty coloring, putting together puzzle pieces, cutting or pasting because of difficulties in visual perception or movement planning.

- Dislike of touch sensations because the child cannot organize and interpret the sensations from the skin. These children often do not like to be cuddled or held or they may seek out roughhousing or hitting activities.

- Difficulty focusing the attention and hyperactivity. Many of these children are very irritated or distracted by specific kinds of light or noise.

- When these children enter school they have major difficulties with social interaction and academic learning. Social skills, reading, and math all require the child to integrate sensory information at a very high level.

NEUROLOGICAL ORGANIZATION AND SENSORY INTEGRATION

Sensory integration occurs at all levels of the central nervous system. However, the brain stem (including the midbrain, pons, and medulla oblongata) appears to play the most significant role in sensory processing. The brain stem and the thalamus receive sensory information from every sensory modality. Information passing through these structures is modified, integrated with other sensory information and directed to the cortex of the brain.

As multiple sensory information impinges upon the brain, a finely-tuned filter system comes into play. Sensory input pertinent to the learner's inner needs and goals reaches a level of consciousness. Input which is less important or distracting is dampened down centrally . The reticular formation in the brain stem (which plays the central role in this filter system) is often considered the master control mechanism of the central nervous system. It helps the brain to focus on one type of sensory input by inhibiting other types of input. This allows the individual to focus attention, and reduces the level of distraction.

Children who have been labeled hyperactive are unsuccessful in filtering out irrelevant information. They are pulled from one experience to the next and are unable to maintain the focus of attention needed for successful learning. Children with severe difficulties in filtering and organizing sensory information may live in such a confusing and threatening world that they experience what we might call sensory overload. In order to survive the sensory chaos, portions of the brain shut down and the child may appear to be deaf, blind, autistic, or severely retarded.

A calm alert state of mind and body is facilitated by sensory input from the vestibular system acting on the reticular formation. Slow movement such as rocking in a rocking chair is known to be very calming and organizing to a child or adult. Children with severe sensory integrative problems will often sit and rock their bodies to calm themselves and try to organize their sensory world.

SENSORY INTEGRATIVE THERAPY

Sensory Integrative Treatment was developed out of the extensive research of A. Jean Ayres, an occupational therapist with a strong interest in the sensory systems and sensory integrative dysfunction (Ayres, 1964, 1965, 1966, 1972). Therapy provides controlled sensory input (especially input from the vestibular, tactile, and proprioceptive systems) in a way that allows the child to make an adaptive response that integrates the sensations and enhances the organization of the brain. Treatment includes activities that allow sensory integration to occur primarily at the brain stem level. As integration at this level increases, the child is better able to organize the sensory information required for skills such as language, fine motor coordination, and reading.

RELATIONSHIPS BETWEEN THE VESTIBULAR AND AUDITORY SYSTEMS

The effectiveness of facilitation of sensory integration through the vestibular system is a major component Sensory Integrative Treatment. A related or associated alternative to the use of vestibular input may be the use of auditory input. In order to understand the effectiveness of this approach it is important to look at the similarities and relationships between the vestibular and auditory systems.

The vestibulocochlear system can be separated into three functional divisions. The semicircular canals respond to angular or phasic movement. The utricle and saccule respond to linear movement and static positioning. The cochlea and Organ of Corti provide hearing function. All of these components occupy the same anatomical region in the bony portion of the temporal bone. All share common fluids – the perilymph and endolymph.

The VIII cranial nerve (vestibulocochlear nerve) provides the sensory innervation for each of these areas by dividing into two branches, the cochlear nerve, and the vestibular nerve. However some of the nerve fibers from these two branches appear to be shared so that some auditory fibers are carried by the vestibular nerve and some vestibular fibers are carried by the cochlear nerve. Fibers from both systems synapse in the reticular formation of the midbrain enroute to the cortex and cerebellum (Moore 1973). Thus, the receptive systems for hearing and movement are highly interconnected at both anatomical and neurological levels.

Clinical evidence (Gilmor et al 1989, Tomatis 1981, Tomatis 1987) indicates that hearing deficits can upset equilibrium reactions and that balance and postural responses improve when precise listening skills are developed. Many children who have poor hearing and / or listening skills improve their functional use of hearing when vestibular input is used to facilitate movement.

FACILITATION OF SENSORY INTEGRATION THROUGH THE AUDITORY SYSTEM

Vestibular input provides an effective foundation for therapeutic learning for children with sensorimotor disorders. We might ask whether stimulation of the auditory portion of the auditory-vestibular system would create a similar impact on sensorimotor learning. If a similar effect can be identified, the use of specific types of sound could play a major supportive role in the treatment of children with sensory integrative dysfunction.

Hemi-Sync and Sensory Integration

Through EEG studies, it is known that carefully selected and programmed sounds are capable of changing the brain's electrical energy patterns. Oster's work in defining the phenomenon of binaural beats in the brain (Oster 1973), was given practical application by Robert Monroe in the development of Hemi-Sync sounds. Research (Atwater, 1988; Monroe, 1982; Schul,1982; Edrington, 1984b; Hutchison, 1986) supports the theory that different frequencies presented to each ear through stereo headphones or via stereo speakers create a difference tone (or binaural beat) as the brain puts together the two tones it actually hears. For example, if the individual listens to a tone with the frequency of 440 Hz in one ear and another tone of 444 Hz in the other ear a binaural beat of 4 Hz will be produced at a similar amplitude or strength in both hemispheres of the brain. Because of this synchronization Monroe has called this effect Hemi-Sync (short for Hemispheric Synchronization). It is not known whether the synchronization is achieved through integration of the two sounds subcortically or cortically. Atwater (Atwater, 1988) has hypothesized that binaural beats originate in the two superior olivary nuclei in the brain stem which receive nerve fibers from both the right and left ears. Further integration of auditory information traveling to the right and left cortical hemispheres occurs through the nerve fibers of the corpus callosum which connect the two hemispheres.

Hemi-Sync is an excellent example of the sensory integrative process of the brain. Two independent auditory signals are integrated in a way that produces a whole (i.e. Hemi-Sync) which is different from each of the separate parts. Initial processing and integration occurs in the brain stem. In addition, the tendency toward synchronization of the right and left hemispheres appears to enhance attention, sensory and extra-sensory awareness, and intuitive processing, and to increase successful adaptation to personal experiences.

The use of Hemi-Sync in the therapy-learning environment of the young child with a sensorimotor disability is yielding promising results. Both clinical experience and preliminary research indicates that the addition of Hemi-Sync signals (containing frequencies which produce more theta patterns in the brain) to the background music increases the child's focus of attention and creates a mental set of open receptivity. Positive feedback and suggestions about ease and success of learning are provided while the child is in a focused state and is more accepting of new possibilities. In a pilot study of 20 developmentally disabled children (Morris, 1986), each child participated in therapy to remediate feeding and pre-speech problems for an initial period without music in the Learning Environment. This was followed by a period in which calming music was added. A third period introduced Hemi-Sync signals into the same music.

Informal data was recorded to document the child's progress under each condition. Two of the children responded negatively to the music containing Hemi-Sync, and its use was discontinued. Fifteen of the remaining 18 children who continued to receive the music containing Hemi-Sync showed positive changes in the behaviors being worked on in treatment. Changes which were observed included improved focus of attention, reduction in tactile defensiveness and overall improvement in sensory organization, increased physical relaxation, improved motor coordination, and reduction in fearfulness. All of the children exhibited a greater openness and enthusiasm for learning. During the initial treatment sessions that did not utilize a musical or Hemi-Sync background these changes were not evident. In several instances behavioral changes were noted with the calming music background; however the degree of change and permanence of change was more pronounced when Hemi-Sync was combined with the music. Three of the 18 children showed minimal or inconsistent changes in their behaviors with Hemi-Sync.

Varney (1988) completed a study of six boys between the ages of 15 and 29 months who were enrolled in home-based early intervention program. Diagnoses included Down Syndrome, neurological disorder, and developmental delay. She used a modified single subject design to compare the responses of 3 children who listened to Metamusic with Hemi-Sync during weekly one-hour intervention sessions for a period of 4-5 weeks to the responses of three matched children who listened to the same music without the Hemi-Sync signals. Five of the six children in the study demonstrated improvements during intervention. The three children who listened to Metamusic with Hemi-Sync during intervention demonstrated greater improvement than the children who listened to the same music without Hemi-Sync.

She concluded that playing Metamusic with Hemi-Sync during intervention appeared to improve the imitation of gestures, facial expressions, two-word phrases , and spontaneous use of two-word phrases. Significant increases in attending behaviors and child-initiated interactions also were observed. During intervention with Metamusic with Hemi-Sync changes in behavior occurred more quickly than would be expected. All three of the children who listened to the Metamusic with Hemi-Sync demonstrated steeper slopes of change during intervention. For example, one child increased recorded behaviors from 0% to 100% between the first and second intervention sessions. The other two children made increases of 42-45% between two or more intervention sessions. These changes also occurred earlier in the intervention program than did the changes observed in the three children listening to the music alone. Seizures did not increase for the child with a neurological disorder and history of a seizure disorder during the period in which the Hemi-Sync signals were included in the intervention. This is also in agreement with the findings of Morris (Morris 1983, Morris 1985). Varney concludes that the study "..offer(s) evidence supporting the use of Metamusic with Hemi-Sync as an effective adjunct to a communication program which is appropriate to the needs of young children with developmental disabilities...Although the usefulness and effectiveness of Metamusic with Hemi-Sync requires additional empirical evidence, interventionists may find that playing Metamusic with Hemi-Sync during intervention with young children with developmental disabilities will improve attention behaviors, social interactions and communication. " (p44-45).

Clinical observations indicate that the use of Hemi-Sync music contributes to a positive learning environment for both the child and therapist. The following examples illustrate the types of changes which were observed during a period where Hemi-Sync tapes were used for 1-2 hours per week with children whose severe sensory integrative dysfunction was a major component of the disability (Morris 1985). Baseline observation periods of responses without background auditory input, and with a music background were used for comparison. Other treatment techniques were unchanged as Hemi-Sync was added to the program.

A four-year-old boy with ataxic cerebral palsy and severe mental retardation with sensory integrative dysfunction initially showed severe distractibility, irregular breathing patterns, and breath-holding when moving or eating. He had learned to move into a crawling position on his hands and knees but was unable to crawl more than 2-3 feet. Touch to his body or sounds in the room were so distracting that his attention was immediately diverted, and he fell over. Attempts to use techniques to increase postural tone and postural stability were unsuccessful because of his disorganized response when he was physically handled. His initial response to Hemi-Sync music was highly variable. During some sessions he was physically calm, and attention and coordination improved. In other sessions there appeared to be no effect. Change was initially noted in a regularization of the breathing patterns. Breath-holding episodes occurred less frequently and a deeper, more regular pattern emerged. During periods of quieter breathing, his attention was focused and he was able to listen and accept touch to his body without wiggling and grabbing the therapist's hand. Activities to improve postural stability and facilitate normal movement sequences were accepted and enjoyed. During this period he began to crawl throughout his home. He was able to remember the location of favorite rooms and began to explore cupboards and drawers. This was related to a more focused attention span and a reduction in tactile hypersensitivity.

An 10-month-old boy with cerebral palsy showed severe disorganization of his response to sensory input and sensory overload. Because of difficulty filtering out unwanted sensory information, he began to withdraw from a confusing, overwhelming world. He flapped his hands, rocked back and forth, and used poor eye contact with adults caring for him. These autistic-like behaviors occurred primarily when he was overstimulated. Baroque music with a 60-beat-per minute tempo was initially introduced into the program. He was greatly calmed by the music, and the rocking and flapping behaviors were absent or reduced with this type of music background. Music with a faster tempo or a poorly defined rhythm increased his disorganization and exaggerated his hyperactivity, rocking, squealing, and hysterical laughing. Although the slow, rhythmical music improved his acceptance of physical handling and his ability to learn during therapy sessions, there was little carryover into situations without the music. After 5 months of treatment with the music background, music containing Hemi-Sync was introduced. His ability to tolerate touch to the head, face and mouth improved, and he was calmer and more focused during treatment sessions. Major gains were made in eye contact, socialization and language skills. All sensorimotor and communicative responses were qualitatively better during Hemi-Sync treatment sessions. By 22 months he was consistently able to maintain an appropriate control of attention and learning without the assistance of special auditory input. The periods of self-stimulation and withdrawal occurred with less frequency and were reduced in intensity and duration. They were seen primarily in a highly overstimulating environment, or when he was fatigued or frustrated.

A 6-year-old girl with severe developmental delays, autistic-like behavior, severe sensory integrative dysfunction, and self-abusive behaviors was referred because of delays in feeding abilities. She took liquids only from the bottle and did not take textured food well. She refused most lumpy foods and liked only a few tastes in pureed foods. She disliked touch of any kind and even crawled with her feet in the air because of her intense dislike of contact of her feet and ankles with the floor. Her behavior became very disorganized and disruptive whenever the sensory input from the environment was increased. She pulled her hair, beat her head against the wall, and screamed when she became upset. Although her postural stability was poor, treatment techniques commonly used to build and stabilize tone were rejected because they involved some degree of touch or physical guidance. Her mother stated that she loved music but it had never been used in therapy or the classroom because her teachers felt that it would distract her and prevent her from learning. When slow music with a 60-beat per minute tempo was introduced into the first therapy session, she became much calmer and accepted some touch from the therapist. Music with Hemi-Sync was introduced during the second session. Within 5 minutes she quieted dramatically and focused her attention for long periods on a picture book. She became interested in touch and movement in her feet and invited the therapist to explore movement contrasts in her feet and legs. The calming, organizing effect of the music lasted for approximately 2 hours after she returned home. She continued to make quantum gains in her weekly therapy sessions and made the transition to table foods within four treatment sessions. The focus in treatment was placed upon sensory organization and integration using Hemi-Sync to facilitate a normalization of response to touch and movement. With greater acceptance of physical handling, techniques to improve postural control were incorporated into the program. Activities which focused on sensory awareness and contrasts in her body were well-accepted and increased her ability to select newer, more appropriate movement patterns.

The introduction of Hemi-Sync signals into the therapy environment must be done with care and with close observation of the child’s nonverbal signals. Several children have been seen who responded negatively to Hemi-Sync. One infant cried each time a tape with the Hemi-Sync signals was used. An older boy became more hyperactive with the Hemi-Sync tapes. Both were calmed and became better organized when slow Baroque music was used as a background to the therapy session. Each child is unique. Clinical generalizations are difficult to make with the limited data available at this time. For example, although two children with sensory organizing difficulties responded poorly to the tapes, a third child whose clinical behaviors were similar, responded positively and made major gains in reducing seizures, improving her focus of attention, and developing some basic communication skills when Hemi-Sync tapes were included in her program (Morris 1983).

The music with which the Hemi-Sync is combined can determine the child’s response. Most children and adults show normal preferences with likes or dislikes for specific musical selections. However, some children with sensory integrative dysfunction may find that certain pieces of music are very disorganizing to their nervous systems. Other pieces of music may be very calming and organizing. It appears that if Hemi-Sync is blended with a piece of music that is neutral or very organizing to the child, the positive aspects of the Hemi-Sync will predominate. If the same Hemi-Sync signals are blended with a piece of music that the child finds agitating and disorganizing, the overall response will be negative, despite the presence of Hemi-Sync.

A Possible Explanation

Although many changes in sensorimotor and communicative behaviors have been observed with the addition of Hemi-Sync music to the Learning Environment (Morris 1983, Morris 1985, Varney 1988), the most significant changes are related to changes in sensory organization and attention. Problems in sensory processing make it difficult to learn from the sensory environment and reduce the ability to accept physical handling for movement, feeding, and speech facilitation. The systematic use of Hemi-Sync to improve sensory integration can help children become more organized and able to accept, integrate, and enjoy being held, touched, and moved. The clearest changes have been observed in the child's ability to accept and learn from touch.

Explanations for the changes observed with Hemi-Sync are not clear; however, they may be linked to the facts and observations that are currently used in Sensory Integrative (SI) Treatment.

Ayres (1972) describes an approach to the normalization of tactile defensiveness which is based, in part, upon the theories of the English neurologist, Henry Head (Head 1920). Two distinctive neurological pathways mediate tactile information. The spinothalamic system mediates primitive tactile information which provides basic survival input. This is the earliest to develop in the infant. The dorsal-lemniscal system mediates the more sophisticated discriminative tactile information which provides highly specific information about the nature of the tactile input. Both of these pathways go through the thalamus and other portions of the limbic system, and thus are tied in with emotional responses. The system responsible for discriminative touch keeps the mechanism for survival under control. When the later is dominant, the child exhibits characteristics associated with tactile defensiveness (i.e. strong dislike of touch, negative emotional responses to being touched). Thus, the development of discriminative skills enhances this balance and reduces or eliminates tactile defensiveness.

Research (Ayres 1964, Ayres 1965, Ayres 1966) shows a high correlation between tactile defensiveness, hyperactivity and distractibility in children with sensory integrative dysfunction and specific learning disabilities. Ayres implies that tactile defensiveness creates the distractibility which expresses itself in hyperactivity. The degree of tactile defensiveness varies with the child's emotional state. Based upon Ayres' theories and research, children with tactile defensiveness are usually treated through the use of deep touch-pressure stimuli, often combined with vestibular input. Many who participate in programs that emphasize reduction of tactile defensiveness simultaneously develop better focus of attention and reduced hyperactivity.

In the developmental model hypothesized by Head (1920) the shift from the more primitive survival mode of touch to more mature tactile function depends upon the development of neural pathways that enable tactile discrimination. Discriminative function depends upon the ability to perceive a sensory pattern, store the information from this perception in memory, retrieve the memory as a second sensory pattern is introduced, and compare the two memories. Finally a same-different distinction is made. From a learning perspective, this requires the ability to focus attention, store information in memory, and retrieve and compare pertinent information.

It is possible that the most important factor in the development of discrimination is focused attention. The correlated presence of attention deficits and hyperactivity in children with tactile defensiveness and poor tactile discrimination may implicate attention as the predominant factor, not tactile dysfunction as is presently assumed. The construct underlying tactile defensiveness may be clinically generalized to other sensory systems, leading to a broader construct of sensory defensiveness. When children experience severe difficulties with sensory defensiveness and problems filtering out irrelevant sensory input, they may be described as experiencing sensory overload. The primary deficit in focused attention is clearly evident in these children.

States of consciousness in which the two hemispheres of the brain are in greater synchrony (i.e. hemispheric synchronization) are associated with greater focus of attention. This coherence of brain function as reflected in EEG patterns occurs through the creation of binaural beats in the brain through auditory introduction of Hemi-Sync signals. Subjective reports from thousands of normal adults who have experienced Hemi-Sync describe a feeling of inner calmness, emotional relaxation, and pleasure (The Monroe Institute). One can presume from these reports that the limbic system is involved in the resonant entrainment process. Memory storage also occurs in the limbic system – primarily in the hippocampal gyrus. Music is processed through the limbic system and has been shown to enhance memory storage and retrieval. Emotional and physical relaxation, and increased memory abilities are associated with high receptivity for learning and high retention.

Based upon these theories and observations, a program utilizing Hemi-Sync signals should assist the learning process for the child with sensory defensiveness which interferes with sensorimotor learning. Hemi-Sync creates physical and emotional relaxation and reduces the constant vigilance and fearfulness created by past negative experience with touch and movement. Increased hemispheric synchronization facilitates mental alertness and a clear focus of attention. The calming of the limbic system response combined with clearly focused attention for the learning of discriminative responses, creates a context in which sensory defensiveness can be reduced and integrated. In addition many of the same pathways and processes currently activated by vestibular stimulation may be involved because of the anatomical and neurological similarities between vestibular and auditory systems. Thus, it appears to be possible to organize or integrate the sensory system through the auditory and attentional mechanisms as an alternative to organization through the tactile-vestibular system. The end product is the same. This author's experience with programs utilizing Hemi-Sync in the Learning Environment has found that the child's aversive responses totouch and other sensations can be reduced or eliminated. With greater acceptance of touch and movement, small contrasts can be provided which enable the child to develop and enhance sensory discrimination. As discrimination skills evolve within the sensory system, the survival sensory system is brought into balance and sensory defensiveness is permanently reduced.

The proposed model addresses primarily the sensory integrative dysfunction described as tactile defensiveness. However, clinical experience indicates that other sensory integrative difficulties such as developmental apraxia, disorders of form and space perception, auditory-language disorders, and unilateral disregard, are also helped by Hemi-Sync. Traditional treatment of these children has utilized a great deal of vestibular and tactile sensory input. Research to explore the addition of specific auditory facilitation with Hemi-Sync is warranted.

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